Voyager Bulletin

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YOUNG SURFACE — Even before discovery of Io's active volcanoes, the lack of impact craters suggested that the surface is relatively young. The reddish, white and black areas are probably surface deposits, possibly consisting of mixtures of salts, sulfur and sublimate deposits. Many of the black spots are associated with craters, probably of volcanic origin. The smallest features visible are about 10 km (6 mi) across in this photo taken by Voyager 1 on March 5, 1979 at a range of 377,000 km (234,300 mi).

CLOSE LOOK AT Io — Io's equatorial region contains a myriad of complex features: mountains and plateaus bounded by scarps that vary from irregular to linear, vast smooth plains, rough bright areas. This image was acquired on March 5, 1979, at a range of 82,500 km (51,300 mi) and shows an area approximately 600 km (370 mi) square.

"There is no such thing as a boring Galilean satellite."
L. A. Soderblom
Deputy Team Leader, Imaging Team

Prior to the Pioneer spacecraft's observations in 1973-74, Jupiter's five innermost satellites, including the four largest, the Galileans, were mere pinpoints of light to man, indistinguishable except for their positions. By March 6, however all five had become unique, distinctive individuals.

Before Voyager, these satellites were as unknown as the planet Mars was in 1700. Voyager 1 scanned them at resolutions comparable to the Mariner observations of Mars in the early 1970's – in effect, 270 years of planetary exploration compressed into five days.

Amalthea

Tiny Amalthea, innermost of Jupiter's companions, had never been photographed with any spatial resolution. Weeks of Earth-based observations, combined with Voyager's optical navigation photos and computer calculations, were required to pinpoint its orbital path so that accurate pointing instructions could be given to the cameras.

Barely 140 km (90 mi) high by 260 km (160 mi) long, Amalthea always points its long axis toward Jupiter. Its elongated shape may suggest that it is on the verge of being broken apart by a tug of war between the gravities of Jupiter and the satellites.

Taken from a distance of about 421,000 km (262,000 mi) with a resolution of about 8 km (5 mi), photos of Amalthea confirmed its reddish coloring. Its reflectivity is very low, however, so that its surface composition is probably not ice, frost, or sulfur.

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Puzzling Io

Of all the satellites, Io generated the most excitement. As Voyager 1 closed in on Io, the puzzle was why its surface, so cratered and pocked when viewed from a distance, began to look smoother and younger as the spacecraft neared. Theories of erosion due to intense bombardment from Jupiter's radiation were advanced.

But the mystery was solved with the discovery of active volcanoes spewing sulfur 160 km (100 mi) high and showering it down on the crust, obliterating the old surface. Infrared data indicated hot spots at the locations of the plumes identified in the photographs, confirming the find.

Io's is undoubtedly the most active known surface in the solar system, surpassing even the Earth. If a spacecraft were to fly past Earth, it is unlikely that any volcanic activity would be visible despite the great number of volcanoes. But Io! As many as seven simultaneously erupting volcanoes have been identified.

Most of Io's volcanoes are extremely violent – similar to Vesuvius or Etna. Some evidence of Hawaiian-type volcanoes exists – vents through which the hot magma oozes rather than erupts. Infrared studies have observed lava lakes which may be as much as 400 degrees Fahrenheit warmer than the surrounding surface.

The source of Jupiter's hot sulfur torus is no longer a mystery. But the questions are now: What heats Io? Does the volcanic material come from the core or is it scraped from the underside of the continually overlaid crust? What is the propulsive gas forcing the material out through the volcanic vents, since Io's surface appears waterless?

One theory is that a tug of war between Jupiter and the other Galilean satellites has created gravitational tidal forces that have melted Io's core. Or, Io may have an extremely thin crust which is constantly being scraped away by the interior heat, shot out through the volcanic vents, redistributed on the surface, covered over by subsequent eruptions, and continually recycled in this way, with some ions and neutrals escaping into space to form the sulfur torus.

Voyager 2 will take a series of photos of Io over a 10-hour period to make a time-lapse sequence of the exploding volcanoes and their dynamics.

As Voyager 1 plunged under the south pole of Io, it was expected to pass through a highly-charged region known as the flux tube, where as much as 1 million amperes of electrical current travel along magnetic field lines connecting the satellite with the planet. Preliminary data indicate that Voyager 1 did not pass through the flux tube; the location of the tube had shifted from predictions.

Europa

Voyager 1 had only a distant look at Europa, the third satellite from the planet, but the photos are tantalizing and Voyager 2 will fly half a million miles closer to the amber-colored satellite, returning pictures at about the resolution of Voyager 1's Jupiter photos. Slightly smaller than Io, Europa is also a rocky body seemingly coated with ice and frost. Dark streaks 80 by 1900 to 2900 km (50 by 1200 to 1800 mi) may represent a system of large fractures or faults on the surface.

Summary

With one spacecraft 53 million km (33 million mi) beyond it and another approaching from 54 million km (34 million mi), Jupiter is well-surrounded by curious Voyagers from Earth.

Now 73 days from its closest approach to the planet, Voyager 2 has begun its Jovian observations which will reach a peak on July 9. Approaching on a different sunline than the first ship, the second spacecraft will augment the findings, rounding out the picture of the Jovian system. In addition, changes since Voyager 1's passage will be studied.

Voyager 2 is scanning the entire system in the ultraviolet, sampling Jupiter's radio emissions and interactions with the solar wind, and taking selected pictures.

Currently in a quiet cruise mode, Voyager 1 has passed the half-way mark on its journey from Earth to Saturn. The active program in the computer command subsystem aboard the craft is designed to nearly automate its activities during the next four months so that Voyager 1 needs minimal attention while Voyager 2 takes center stage.

More Results from Voyager 1

There is much for the second spacecraft to look forward to – another look at the ring, measurements of the extremely active solar wind, closer looks at some of the satellites, and different views of all, including the ever-changing face of Jupiter. And Voyager 2 will not be subjected to as severe a radiation hazard as was its sister ship, since it will fly further from the planet.

A Ringed Planet

Floating 35,000 miles above Jupiter's visible cloud tops, a wafer-thin ring of rocky particles poses a new problem. No longer is the question: Why are some planets (Saturn and Uranus) ringed? But: Why are the inner, terrestrial planets not ringed?

Bowshock

On its inbound leg, Voyager 1 recorded at least five crossings of the bowshock as Jupiter's magnetosphere expanded and receded under varying pressure from the solar wind. The bowshock is the line of interaction between the particles trapped by a planet's magnetic field and the particles in the solar wind. The first crossing was February 28, about 6 million kilometers (3.8 million miles) from the planet. The last crossing was at 3.6 million kilometers (2.1 million miles).

Radiation

Voyager 1 withstood 1000 times the lethal dose of radiation for humans as it passed between Jupiter and Io. As expected, several of the instruments were saturated, but recovered well once outside the danger zone.